

Forecasting Annual Farm Prices of U.S. Wheat in a New Policy Era

by

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Abstract

Factors affecting U.S. wheat prices are changing due, in part, to farm policy's reduced role in price determination. Such changes have prompted a review of existing price forecasting equations for U.S. wheat. A model is developed to forecast the annual farm price for wheat, using a 1975-96 estimation period. Model variables account for changes in the role of agricultural policy. The estimated price equation has coefficients with significant t-statistics and explains 88 percent of the historical variation (log of annual wheat prices).

Keywords: Wheat, farm prices, supply, use, ending stocks, and stocks-to-use ratio.

Introduction

Information regarding wheat prices is critical to market participants who make decisions about managing price risk. Market information is also important to policy makers who have to assess the impacts of domestic or international events upon wheat farm prices.

Concern about U.S. wheat farm prices rose significantly during the 1995/96 crop year, as world crop shortfalls caused USDA's price projection for the crop year to rise from a range of \$3.25-\$3.65 per bushel in May 1995 to \$4.20-\$4.50 per bushel in November 1995. Two years later, as world production recovered, producers' wheat prices are expected to fall. USDA's price projection for 1997/98 dropped from a range of \$3.60-\$4.20 in May 1997 to \$3.05-\$3.65 in August 1997.

Price information has become even more important due, in part, to changes in U.S. agricultural policy. The Federal Agriculture Improvement and Reform Act of 1996 (1996 Act) continues the sector's trend toward market orientation. The Act suspends the Farmer-Owned Reserve (FOR) and caps wheat loan rates at the 1995 level of \$2.58 per bushel, well below current and expected future market prices. Such a situation suggests little, if any, government stockholding, which may contribute to increased price sensitivity.

The 1996 Act also eliminated government price assurances. Under the Act, annual production flexibility contract payments remain fixed regardless of market prices, in contrast to deficiency payments that varied inversely to market prices. Consequently, producers face greater risk of income volatility because of market price variation.

Previous analyses have studied relationships between prices and ending stocks for corn (Baker and Menzie; Van Meir; and Westcott, Hull, and Green), wheat (Westcott, Hull, and Green), and rice (Hoffman, Livezey, and Westcott; and Lin, Novick, and Livezey) as a price-forecasting tool. Can such a relationship continue to provide short- and long-term price forecasts in the new policy environment?

This article presents a model designed to forecast the U.S. season average price of wheat at the farm level.¹ The U.S. Department of Agriculture (USDA) analyzes agricultural commodity markets monthly and publishes annual current year market information, including price projections. Because of policy changes, price forecasting equations need to be re-evaluated.

¹ This price model is one of many price forecasting tools used by the USDA. Other price forecasts used by USDA are based on futures market prices and other econometric models. Analysts' expert opinions also enter into the forecasting process.

Background: Factors Affecting the U.S. Farm Price of Wheat

Some of the most important variables to be considered in forecasting the price of wheat include supply and demand factors and domestic agricultural policy (appendix tables 1, 2, and 3). Prices are determined by the interaction of the supply and demand functions which are influenced by government policies. The supply and demand components are briefly discussed because they affect the stocks and use variables that are included in the price equation.² Agricultural policies may also affect the factors of supply and demand. Many of these effects are captured in the stocks or use variables; those not captured will be accounted for separately in the price model.

Wheat Supply

The elements of supply are beginning stocks, imports, and production. Wheat is the principal food grain in the United States and throughout much of the world. The United States is the third largest producer of wheat in the world, averaging 61.6 million metric tons in 1994-96, or 11 percent of world production. U.S. wheat's farm value of production totaled \$9.8 billion in 1996, the fourth largest of all field crops or 11.4 percent of total U.S. crop value.

Beginning Stocks--Last year's carryover becomes this year's beginning stocks. Large or small carryover levels usually have the most impact on price. Large stocks can provide a cushion in a short crop year while a low carryover may exacerbate a low production situation.

Imports--Wheat imports, an insignificant factor for U.S. supply for many years, were fairly low in volume and less than 1 percent of supply between 1960 and 1989. However, wheat imports became an issue in the 1993/94 marketing year as they reached 109 million bushels, including products, or 4 percent of supply. Imports have since declined to about 3 percent of supply, but the U.S. remains an attractive market for Canadian wheat.

Production--U.S. wheat production, the major component of supply, is determined jointly by the area harvested for grain and yield per acre. Until the 1996 Act, acreage planted and harvested was affected by farm

program requirements and participation rates. The relationship between area planted and harvested varies substantially by region although it is fairly stable at the national level. Producers in cattle feeding areas typically graze out some of their wheat fields, rather than harvesting them for grain.

Prior to 1992, sharp declines or increases in planted area were usually the result of changes in government programs requiring acres to be idled. In an effort to control production, support farm income, and limit government costs, various acreage limitation programs were employed, such as the acreage reduction program, paid land diversions, 50/92, 0/92, 0/85 0,50/85-92.^{3 4 5 6} These supply management programs were eliminated in the 1996 Act. Thus, market prices rather than farm programs now have a greater influence on acreage planted to wheat.

Average U.S. wheat yields rose from around 30 bushels per acre in the mid-1970's to an average of 38 bushels per acre in the 1990's. Wheat yield growth has slowed

³ If supplies were estimated to be in excess by the U.S. Department of Agriculture, acreage reduction programs (ARPs) were required and paid land diversion programs (PLDs) were permitted. Wheat producers had the option of under-planting their maximum payment acres and receiving deficiency payments on a portion of the under-planted acres (0,50/85-92).

⁴ 50/92--A program that allowed cotton and rice growers who planted at least 50 percent of their permitted acreage to receive 92 percent of their deficiency payments under certain conditions. The Farm Disaster Assistance Act of 1987 also authorized 50/92 for wheat, feed grains, cotton, and rice producers who were affected by a natural disaster in 1987 and met certain criteria stated in the law.

⁵ 0/92-- An optional acreage diversion program that allowed wheat and feed grain producers to devote all or a portion of their permitted acreage to conserving uses and receive deficiency payments on that acreage. The program made deficiency payments for a maximum of 92 percent of a farm's permitted acreage. Under other types of acreage diversion programs, such as acreage reduction programs, producers cannot receive deficiency payments unless permitted acres are devoted to producing a crop.

⁶ 0,50/85-92--The Omnibus Budget Reconciliation Act of 1993 provided for budget savings by changing the 0.92 provisions to 0-85/92. Producers who wanted to participate in the new "standard" 0/85 program had to idle or plant to selected crops at least 15 percent of their maximum payment acres to be eligible for guaranteed deficiency payments on up to 85 percent of the maximum payment acres. Under certain conditions, producers could have under-planted their wheat acres and received payments on up to 92 percent of their maximum payment acres. These conditions include if they plant minor oilseeds, sesame, crambe, or "industrial and other crops"; if they are prevented from planting; or if they have failed acres.

² Stocks are equal to ending carryover inventories and use is the total of domestic and export use.

in the last 15 years. Many factors affect U.S. yields, including climatic conditions, weather, farm management practices, variety, and soil type.

Wheat Demand

Components of wheat demand are food use, feed and residual, seed, exports, and carryover stocks. Domestic use, a growing component of total U.S. wheat disappearance because of increased food use, claims about 50 percent of total disappearance, up from an average 40 percent during 1975-84.

Food--Food use has been the largest and most stable component of domestic use and is characterized by a steady growth rate. Wheat is unique because it is the only cereal grain with sufficient gluten to produce bread without requiring mixing with another grain. The domestic demand for wheat food use is relatively unaffected by changes in wheat prices and disposable income and is closely tied to population, tastes, and preferences.

Feed and Residual--Feed and residual use is more variable than food use and is related to corn/wheat prices and wheat crop quality. Wheat feed use is particularly prominent at wheat harvest time when wheat prices are low and new crop corn and sorghum remain to be harvested. Feed and residual use totaled about 19 percent of total disappearance in the 1986 and 1990 crop years, years of lower wheat prices, compared with about 6 percent during 1988 and 1995, which had higher wheat prices. The residual component includes negligible quantities of wheat used for alcoholic beverages and estimation error from other categories.

Exports--Exports are important to the U.S. wheat market, as U.S. exports account for about half of the total disappearance. In fiscal 1996, wheat exports accounted for 11.7 percent of the total value of U.S. agricultural exports, or \$7.0 billion. The United States is the world's largest exporter of wheat with a world market share of about 33 percent.

Food Aid under P.L. 480,⁷ guaranteed export credit, and special export programs have helped U.S. wheat exports. Between 1986 and 1994 as many as half--or more--of U.S. wheat exports received Export Enhancement Program (EEP)⁸ subsidies (fig 1). EEP has not been used for U.S. wheat exports since July 1995. It is unclear whether EEP will be used in the future, but the 1996 Act authorizes its use at reduced levels.

Carryover Stocks--Carryover stocks reached levels greater than one billion bushels between 1981 and 1987, with ending stocks representing an average of 60 percent of one year's use. However, as policies steered the sector toward greater market orientation, ending stocks declined and a more balanced supply and use situation arose in 1991-96 with an average stocks-to-use ratio of 21 percent.

Agricultural Policies

Domestic agricultural policies may also affect the factors of supply and demand. Many of these effects are captured in the stocks or use variables. For example, Government price support programs have affected levels of carryover stocks over time. Between the 1973 and 1996 Farm Bills, the loan program,⁹ farmer-owned

⁷ Public Law 480 (P.L. 480)--The common name for the Agricultural Trade Development and Assistance Act of 1954 (P.L. 83-480), which seeks to expand foreign markets for U.S. agricultural products, combat hunger, and encourage economic development in developing countries. Also the Food for Peace Program. Title I of P.L. 480 makes U.S. agricultural commodities available for financing export sales on concessional terms, for example, at low interest rates for up to 30 years. Donations for emergency food relief and non-emergency humanitarian assistance are provided under title II. Title III authorizes a Food for Development program that provides government-to-government grant food assistance to least developed countries. The 1996 Act extends the authority to enter into new P.L. 480 agreements through 2002.

⁸ The Export Enhancement Program (EEP) was initiated in May 1985 under the Commodity Credit Corporation (CCC) Charter Act to help U.S. exporters meet competitors' subsidized prices in targeted markets. The program was later authorized by the Food Security Act of 1985 (P.L. 99-198); the Agricultural Trade Act of 1978, as amended by the Food, Agriculture, Conservation, and Trade Act of 1990 (P.L. 101-624); the Uruguay Round Agreements Act (P.L. 103-465); and the 1996 Act (P.L. 104-127). Under the EEP, exporters are awarded cash payments, which enable an exporter to sell certain commodities to specified countries at competitive prices. The 1996 Act caps EEP program levels annually through 2002 and allows the Secretary, under certain conditions, to target up to \$100 million annually for the sale of intermediate-value products.

⁹ Price support for wheat producers is provided through nonrecourse loans at the announced price support loan rate. A participating farmer can pledge his crop as collateral to the Commodity

reserve, food security reserve and production controls have been used to support prices. Also, various export programs may enhance consumption of wheat by subsidizing the price of wheat. How these programs affected the price and stocks-to-use relationship is important for modeling wheat prices. Situations where policies altered the market price and stocks-to-use relationship must be specifically accounted for in the price equation. Consequently, a review of agricultural policies is necessary to determine when the price and the stocks-to-use relationship were adjusted.

The Agriculture and Consumer Protection Act of 1973 changed the existing income programs by replacing the wheat certificate program with the target price concept (Harwood and Young). Carryover stocks consisted only of free stocks in 1974-76, and the stocks-to-use ratio ranged from 26 to 65 percent for those years. Because grains and oilseeds generally had favorable prices during 1974-76, there was an effort to make farm programs more market oriented. The target price, accompanied with deficiency payments, was designed to support income without affecting market price. However, strong prices in 1974-76 led to increased production and larger stocks (appendix tables 1 and 2).

The Food and Agriculture Act of 1977 established the Farmer-Owned Gain Reserve (FOR), a response to the growing importance of exports and the potential for greater global demand and price instability. In return for loans and annual storage payments, farmers agreed not to market their grain for an extended period (3 to 5 years), unless the average farm price reached a specified release price. The FOR allowed the producer to maintain ownership of the grain rather than forfeit stocks to the government at low prices as occurred under the regular loan program, which did not allow an opportunity to realize a gain if prices rose.

The FOR loan rate and the regular wheat loan rate appeared to heavily support annual farm prices during the late seventies to mid-eighties (figs. 2, 3, and 4). Prices approached the loan rate in 1977, the year the FOR was introduced. Minimum loan rates were then

written into the Agriculture and Food Act of 1981. The regular loan rate for wheat, \$3 a bushel in 1980, reached \$3.65 in 1983; defaults to the CCC rose and CCC stock levels surged. In reaction, loan rates were reduced to \$3.30 in 1984 and 1985. During the mid-1980s, market prices were pressured downward when accumulated CCC stocks were released in the market. In retrospect, the high minimum loan rates of the early 1980's supported prices above market clearing levels.

During 1980-82, the FOR was implemented as a price enhancement tool and offered producers reserve loans at rates above the regular loan rate. This situation raised questions about the FOR's goal--price stability or price enhancement. The FOR loan rate was set at \$4.00 per bushel in 1982/83, \$0.45 above the regular loan rate. Harvested acres were the second highest ever in 1982/83, contributing to a rise in ending stocks to 1.52 billion bushels, of which over 1 billion bushels were in the FOR (fig. 3).

The Food Security Wheat Reserve (FSWR), created in the 1980/81 marketing year, provides a government-held reserve of up to 4 million metric tons of wheat for emergency food needs in developing countries. This reserve was also part of the Government's response to criticism for the Russian grain embargo. The authority for the Food Security Wheat Reserve was repealed with the 1996 Act and a new Food Security Commodity Reserve (FSCR) was established that includes corn, grain sorghum, and rice, in addition to wheat.

In general the FSCR has not been a major factor in the wheat market as estimated price impacts were minimal. The FSCR was established in 1981 with 4 million metric tons of wheat. The reserve has been tapped 6 times since its inception in 1981--3 times to meet P.L. 480 commitments when supplies were tight and 3 times to meet unanticipated emergency needs. The volume released ranged from 59,000 metric tons in 1991 to 1.4 million metric tons in 1989. Replenishment of the reserve was made during times when CCC stocks were generally large, but the last time this occurred was in 1991. Presently, 2.5 million tons of wheat are in the reserve.

Because of large stock buildups, the Food Security Act (FSA) of 1985 was designed to increase U.S. competitiveness in world markets and to support farm income (Hoffman, Schwartz, and Chomo). The FSA moved agriculture toward a more market-oriented farm policy that would enable farmers to respond to economic

Credit Corporation (CCC) and then receive a 9-month loan pledged at a predetermined rate per bushel. If the market price is above the loan rate plus interest, the producer usually repays the loan with interest. However, if the market price is below the loan rate plus interest, the producer may forfeit the wheat at the end of the loan term to the Commodity Credit Corporation in full satisfaction of the loan.

and market signals. The legislation lowered loan rates and provided discretionary authority for their adjustment, modified the FOR to prevent large buildups in stocks, reversed upward trends in target prices, generally froze program yields, and authorized EEP and initiated the Targeted Export Assistance Program (TEAP) to promote agricultural exports in response to subsidized competition. The Conservation Reserve Program was implemented with a goal of retiring 40-45 million acres of highly erodible cropland from production for a period of 10-15 years.¹⁰

In 1986, stocks had been equal to 83 percent of total use but declined to 16 percent in 1995 (fig. 4). Generic certificates¹¹ helped reduce the level of government and FOR stocks.

The Food, Agriculture, Conservation, and Trade (FACT) Act of 1990 and the subsequent Omnibus Budget Reconciliation Act of 1990 (OBRA) followed the ground work laid by the FSA of 1985. The FACT Act's main goals were to further reduce spending, to help maintain farm income growth through expanding exports, and to enhance the environment. Major mechanisms used to accomplish reduced budget expenditures and improved agricultural competitiveness were reduced payment acres (as authorized by OBRA) and planting flexibility. The Conservation Reserve Program of the 1985 FSA was altered to cover lands adversely affecting water quality and wetlands, and a new Water Quality Protection Program was added.

The FACT Act of 1990 continued to keep commodity loan rates low and to reduce the role of the Farmer-

Owned Reserve, thereby phasing out government-owned stocks as a stabilizing device. Wheat FOR activity declined under the FACT Act of 1990 and ceased during the 1993/94 marketing year. Annual acreage reduction programs helped maintain stabilization. The stocks-to-use and price relationship seemed to change for 1990-94, possibly due to a number of reasons: a change in EEP program administration where subsidies were switched from generic certificates to cash; passage of trade agreements, the Canada-U.S. Free Trade Agreement and the North American Free Trade Agreement, allowing for increased trade between Canada and the U.S.; and a general policy change that minimizes government stocks.

The 1996 Act continues the trends of the previous two major Farm Acts toward greater market orientation, thereby gradually reducing the Government's commodity program influence in the agricultural sector (Young and Westcott). Annual production flexibility contract payments have replaced the deficiency payment income support mechanism. Price support programs were continued but loan rates were kept at minimal levels, the FOR was suspended, annual supply control programs were eliminated, and planting decisions were decoupled from program parameters.

The 1996 Act continued the marketing loan provisions for wheat but, since the wheat loan rate is capped at the 1995 level of \$2.58 per bushel, significant activity under these provisions is unlikely. Marketing loan provisions for wheat, which began with the 1993 crop year, have had little effect on wheat prices because prices have generally been above the loan rate.¹²

Analytical Framework

This section illustrates how stocks are related to supply and demand within a general equilibrium model and develops the statistical model.

A general equilibrium model is illustrated which reflects competitive behavior (Labys; Westcott). The model features supply, demand, stocks, and a market-clearing identity.

$$S = f_1(p, z, flp)$$

¹⁰ The CRP is a program created by the Food Security Act of 1985 to reduce erosion and protect water quality on up to 45 million acres of farmland. Under the program, landowners who sign contracts agree to convert environmentally sensitive land to approved permanent conserving uses for 10-15 years. In exchange, the landowner receives an annual rental payment and cash or payments-in-kind to share up to 50 percent of the cost of establishing permanent vegetative cover. The 1996 Act caps maximum CRP acreage at 36.4 million acres. The 1996 Act also permits early termination of CRP contracts that are at least 5 years old and meet specified criteria.

¹¹ Negotiable certificates, which do not specify a certain commodity, are issued by USDA in lieu of cash payments to commodity program participants and sellers of agricultural products. The certificates can be used to acquire stocks held as collateral on Government loans or owned by the Commodity Credit Corporation. Farmers have received generic certificates as payment for participation in numerous Government programs. Grain merchants and commodity groups also have been issued certificates through the Export Enhancement Program and the Targeted Export Assistance Program.

¹² In 1993, some loan deficiency payments (LDP's) were made to wheat farmers. Most payments were for soft red winter wheat located in certain Texas counties. Total wheat LDP's paid to farmers were less than \$1 million.

$$D = f_2(p, y, z)$$

$$I = f_3(p, z, flp, D9094)^{13}$$

$$S - D - I = 0$$

Endogenous variables are:

S = supply,

D = demand,

I = ending stocks,

And p = market prices.

Exogenous variables are:

flp = FOR and a loan program,

y = disposable income,

D9094 = a period of an apparent shift in the pricing relationships,

And z = other exogenous variables.

With the system in equilibrium, prices can be determined from the inverse of the stocks function. At that price, the supply and demand levels give an ending stocks estimate consistent with the equilibrium price, through the price-ending stocks relationship.

In the inverse stocks function-price determination equation, prices are negatively related to stocks. Ending stocks of an annual storable commodity, such as wheat, reflect the relationship between supply and use (Labys). If total use rises relative to supply, farm prices tend to rise as ending stocks decline. On the other hand, if supply rises relative to total use, prices tend to decline as ending stocks accumulate.

$$p = f_3^{-1}(I/D, flp, D9094)$$

The stocks variable is transformed to reflect stocks relative to total consumption (Westcott). Therefore, the stocks variable (I) is expressed as a percent of total use (I/D). This is particularly important over time as demand for carryover stocks may increase because of growth in the size of the wheat sector, measured here by total demand.

Prices are expected to be positively related to the loan rate, especially in those years that loan rates were set high relative to market prices and the loan program and

farmer-owned reserve isolated stocks from the marketplace. Price support and stabilization measures tend to increase the price received by producers usually through government purchases.

Entry into the wheat FOR, FOR loan rates, and regular loan rates tended to limit price reductions especially during 1979-85 (fig. 1, appendix table 2, and fig. 2). Many grain price models have been estimated with the dependent variable of price minus loan rate. This relationship was used by Baker and Menzie's annual corn price model, by Van Meir's analysis of corn prices and stocks, and by unpublished wheat price forecasting equations. Such a dependent variable is no longer valid in today's market as market prices are well above support prices.

Although there was a return to market orientation during 1986-96, the different relationships found from 1990 through 1994 could be due to a number of factors (fig. 4). First, EEP program administration switched program subsidies from generic certificates to cash in November 1991. Second, passage of trade agreements, CFTA and NAFTA, allowed for increased trade between Canada and the United States. Third, general policy level changes minimized government stocks. Additional research is required to explain these relationships.

Model Specification

The price-carryout stocks relationship, equation (1), specifies annual producer price as a function of the stocks-to-use ratio, loan rates for the period 1979 through 1985, and a dummy variable to capture a shift in the pricing relationships from 1990-94. Relationships observed in figure 4 indicate that a logarithmic functional form would best fit the data from 1975-96. A double log function is specified and estimated with ordinary least squares (OLS) regression to explain the all-wheat price with 22 observations.

$$(1) \text{ Log}(P) = a + b \text{ Log}(I/D) + c \text{ Log}(FLP) * (D7985) \\ + d (D9094)$$

¹³ Additional determinants of stock demand include differences between current and expected futures prices and interest rates.

Where:

P = Weighted season average farm price for all wheat.¹⁴

a = intercept term. It is hypothesized that this coefficient is positive. If the logarithm of the stocks-to-use ratio is zero, price is expected to be a positive number.

b = Estimated coefficient for the stocks-to-use variable. It is hypothesized that this coefficient is negative. As the stocks-to-use ratio declines, reduced stocks cause increased upward pressure on the farm price. The demand for carryout stocks is less at higher prices.

I = Ending stocks, i.e. total carryover inventories.

D = Total domestic and export disappearance.

c = Estimated coefficient for the FOR and loan program variable, representing 1979-85, when the FOR and loan programs kept market prices artificially high. This coefficient is expected to be positive.

Log(FLP)*(D7985) = An intercept shifter for the years 1979 through 1985, a time when prices were heavily supported by the FOR and loan programs. FLP = Regular loan rate and D7985 = 1 from 1979-85 and zero for other years.

d = Estimated coefficient for a dummy variable that represents an apparent shift in the pricing relationship for the years 1990-94.

D9094 = A dummy variable equal to 1 for 1990-94 and zero for other years. This variable is an intercept shifter, in contrast to a slope shifter.

Data

Data for the estimation of equation (1) are found in *Wheat: Situation and Outlook Yearbook*. Data are shown in appendix tables 1, 2, and 3.

Results

The estimated price equation (table 1) shows that the coefficients for the intercept and loan rates are positive and the coefficient for the stocks-to-use variable is negative, as hypothesized. The coefficient for the 1990-94 dummy variable was negative. The estimated price equation has significant t-statistics and 88 percent of the variation (log of annual wheat prices) is explained by the equation. The t-statistics are shown in parentheses below each estimated coefficient. All estimated coefficients are significant at the 1-percent level.

Table 1: Ordinary least squares estimates for the wheat price equation, 1975-96

(2)	Log(P)	= 2.6225 (19.73)	- 0.40263 Log(I/D) (-11.08)	+ 0.21941 Log(FLP) * D7985 (7.116)
			- 0.2217 (D9094). (-5.522)	

R²=0.883

Standard error of the estimate = 0.066807

Durbin-Watson statistic = 2.2679

Degrees of freedom = 18

Note: Autocorrelation adjustments were not necessary.

Price Forecasts

The annual 1997/98 price forecast for all wheat at the producer level is \$3.54 per bushel, based on results found in equation (3). Price forecasts based on equation (3) and a range of corresponding stocks-to-use ratios are shown in figure 5.

$$(3) P = e^{(2.6225 - 0.40263 \cdot \text{Log}(I/D) + 0.21941 \cdot \text{Log}(\text{FLP}) \cdot D7985 - 0.2217 \cdot D9094)}$$

This price forecast falls within the upper end of the price projection range of \$3.05 to \$3.65 per bushel released in the World Agricultural Supply and Demand Estimates (WASDE) report, August 12, 1997. Based on the August 1997 WASDE report, the projected 1997/98 stocks-to-use ratio was 29.3 percent. Inserting this ratio into equation (3) yields a price projection of \$3.54 per bushel. With the standard error of the estimate equal to 0.0668, there is a two-thirds chance that the price will fall within a range of \$3.31 to \$3.78 per bushel.

Price forecasts and ranges corresponding to different stocks-to-use ratios are shown in table 2.

¹⁴ This price is computed by the USDA's National Agricultural Statistics Service, which conducts a monthly survey to determine the price producers receive. These prices are weighted by the monthly percent of marketings for the total marketing year. In the process each of the five wheat classes are taken into account to arrive at an all wheat price.

Table 2: Season average price forecasts for all wheat, assuming different stocks-to-use

Stocks-to-use ratio	Price projection	Price range ± 1 standard error of estimate
<i>Percent</i>	<i>-----Dollars per bushel -----</i>	
5.0	7.20	6.74--7.70
7.5	6.12	5.72--6.54
10.0	5.45	5.10--5.83
12.5	4.98	4.66--5.32
15.0	4.63	4.32--4.95
17.5	4.35	4.07--4.65
20.0	4.12	3.86--4.41
22.5	3.93	3.68--4.20
25.0	3.77	3.52--4.02
27.5	3.63	3.39--3.88
30.0	3.50	3.27--3.74
32.5	3.39	3.17--3.62

Model Performance

The performance of the wheat price equation (2) satisfactorily computed estimates of annual wheat prices (fig. 5).¹⁵ Although it captured only 6 of the 8 turning points in the period 1975-96, the mean absolute error for the period was \$0.150 per bushel or a mean absolute percentage error of 4.8 percent. The mean absolute error ranged from \$0.006/bushel in 1990 to \$0.329/bushel in 1977. In comparison, the mean absolute percentage error for corn price forecasts during the period 1975-96 for a similar model was \$0.12 per bushel with a mean absolute percentage error of 5 percent (Westcott, 1997).

Conclusions

The wheat price forecasting model's double log price equation related the stocks-to-use ratio of wheat to the annual producer price, explaining the annual farm price of wheat from 1975-96. In-sample performance of this model was deemed satisfactory with 88 percent of the price variation explained. Although the wheat price equation had strong statistical properties, further efforts are needed to explain 1990-94 relationships, which may have been partly affected by interactions with the global wheat marketplace and by the U.S. EEP program, factors not explicitly represented by the model.

¹⁵Performance was based on in-sample statistics. Insufficient observations preclude out-of-sample statistics.

This price model should be used with care. The model may omit other factors that can influence price. However, the effects of these variables may largely be captured in model's variables. The main variables, stocks and use, may be related to each other in ways that suggest use of estimation techniques more sophisticated than single equation regression analysis. Nevertheless, this model--simple, reasonably accurate, and easy to use--is a strong analytical tool in the arena of price forecasting.

Suggestions for Further Research

Several additional approaches seem warranted with the stocks-to-use model.

- The relationship between nominal wheat prices and inflation should be examined.
- The relationship between free stocks and prices should be studied, thereby removing stocks isolated from the marketplace by Government programs. What relationship exists between Government stocks/total stocks and prices?
- EEP, imports, and other global market interactions may affect wheat prices. What effects has EEP had on the U.S. producer price for wheat? How have these effects affected the level of imports? Have imports affected the U.S. producer price for wheat?
- The different effects of food, feed, and export demand represent valuations of wheat quality factors implicit in different uses. The effects of change in the share of different uses on price should be studied.

To accurately forecast prices when a new policy scenario is in effect, we must determine whether stocks-to-use models, simultaneous set of equations models, or simulation models are adequate. Each model type relies upon past observations influenced by past policies and events. In the past 22 years the wheat sector has been free of government and FOR stocks for only 3 years, 1974-76. Other approaches may prove more appropriate.

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Appendix table 1: U.S. wheat supply and disappearance by marketing year, 1974/75-1997/98. 1/

Year beginning June 1	Supply				Disappearance					Ending stocks May 31			
	Beginning stocks	Imports 2/ Production	Total	Domestic use				Exports 2/ Total	Total Disap- pearance	Government owned	Privately owned 4/	Total	
				Food	Seed	Feed 3/	Total						
Million bushels													
1974/75	340.1	1,781.9	3.4	2,125.4	545.0	92.0	34.9	671.9	1,018.5	1,690.4	NA	435.0	435.0
1975/76	435.0	2,126.9	2.4	2,564.3	588.5	100.0	37.3	725.8	1,172.9	1,898.7	NA	665.6	665.6
1976/77	665.6	2,148.8	2.7	2,817.1	588.0	92.0	74.4	754.4	949.5	1,703.9	NA	1,113.2	1,113.2
1977/78	1,113.2	2,045.5	1.9	3,160.6	586.5	80.0	192.5	859.0	1,123.8	1,982.8	43.3	1,129.5	1,177.8
1978/79	1,177.8	1,775.5	1.9	2,955.2	592.4	87.0	157.5	836.9	1,194.2	2,031.1	51.1	873.0	924.1
1979/80	924.1	2,134.1	2.1	3,060.3	596.1	101.0	85.9	783.0	1,375.3	2,158.3	187.8	714.2	902.0
1980/81	902.0	2,380.9	2.5	3,285.4	610.5	113.0	59.0	782.5	1,513.8	2,296.3	199.7	789.4	989.1
1981/82	989.1	2,785.4	2.8	3,777.3	602.4	110.0	134.8	847.2	1,770.7	2,617.9	190.3	969.1	1,159.4
1982/83	1,159.4	2,765.0	7.6	3,932.0	616.4	97.0	194.8	908.2	1,508.7	2,416.9	192.0	1,323.1	1,515.1
1983/84	1,515.1	2,419.8	3.8	3,938.8	642.6	100.0	371.2	1,113.8	1,426.4	2,504.2	188.0	1,210.6	1,398.6
1984/85	1,398.6	2,594.8	9.4	4,002.8	651.0	98.0	407.1	1,156.1	1,421.4	2,577.6	377.6	1,047.6	1,425.2
1985/86	1,425.2	2,424.1	16.3	3,865.6	674.3	93.0	284.2	1,051.5	909.1	1,960.7	601.7	1,303.3	1,905.0
1986/87	1,905.0	2,090.6	21.3	4,016.8	712.2	84.0	401.2	1,197.4	998.5	2,195.9	830.1	990.8	1,820.9
1987/88	1,820.9	2,107.7	16.1	3,944.7	720.7	85.0	290.2	1,096.0	1,587.9	2,683.8	283.0	977.8	1,260.8
1988/89	1,260.8	1,812.2	22.7	3,095.7	725.8	103.0	150.5	979.2	1,414.9	2,394.1	190.5	511.1	701.6
1989/90	701.6	2,036.6	22.5	2,760.7	748.9	104.3	139.1	992.3	1,232.0	2,224.3	116.6	419.9	536.5
1990/91	536.5	2,729.8	36.4	3,302.6	789.8	92.9	482.4	1,365.1	1,069.5	2,434.5	162.7	705.4	868.1
1991/92	868.1	1,980.1	40.7	2,889.0	789.5	97.7	244.5	1,131.6	1,282.3	2,413.9	152.0	323.0	475.0
1992/93	475.0	2,466.8	70.0	3,011.8	834.8	99.1	193.6	1,127.6	1,353.6	2,481.2	150.0	380.7	530.7
1993/94	530.7	2,396.4	108.8	3,035.9	871.7	96.3	271.7	1,239.7	1,227.8	2,467.4	150.3	418.2	568.5
1994/95	568.5	2,321.0	91.9	2,981.4	853.0	89.2	344.4	1,286.6	1,188.3	2,474.8	142.1	364.5	506.6
1995/96	506.6	2,182.6	67.9	2,757.1	883.0	104.1	151.9	1,140.0	1,241.1	2,381.1	118.2	257.8	376.0
1996/97	376.0	2,281.8	90.0	2,747.8	892.0	103.0	310.0	1,305.0	1,001.0	2,306.0	93.0	351.2	444.2
1997/98 5/	444.2	2,530.5	95.0	3,069.7	900.0	100.0	275.0	1,275.0	1,100.0	2,375.0	93.0	601.7	694.7

NA=Not available

1/ Totals might not add because of rounding.

2/ Imports and exports include flour and other products expressed in wheat equivalent.

3/ Residual; approximates feed use and includes negligible quantities used for distilled spirits.

4/ Includes outstanding and reserve loans.

5/ Projected as of August 12, 1997.

Source: *Wheat: Situation and Outlook Yearbook*. U.S. Department of Agriculture, Economic Research Service. WHS-1997. March 1997.

Appendix table 2: Wheat: Carryover stocks, farm prices, and support prices 1974/75-1997/98

Crop year	Carryover stocks				Price received	Loan rate	Target price	Direct payment
	CCC	FOR 1/	Free	Total 2/				
----- Million bushels ----- ----- \$/bushel -----								
1974/75	---	---	435	435	4.09	1.37	2.05	---
1975/76	---	---	666	666	3.56	1.37	2.05	---
1976/77	---	---	1,113	1,113	2.73	2.25	2.29	---
1977/78	48	342	788	1,178	2.33	2.25	2.90	0.65
1978/79	51	393	481	924	2.97	2.35	3.40	0.52
1979/80	188	260	454	902	3.80	2.50	3.40	---
1980/81 *	200	360	429	989	3.99	3.00	3/3.63	---
1981/82 *	190	562	407	1,159	3.69	3.20	3.81	4/ 0.15
1982/83 *	192	1,061	262	1,515	3.45	3.55	4.05	0.50
1983/84 *	188	611	600	1,399	3.51	3.65	4.30	0.65
1984/85 *	378	5/ 654	393	1,425	3.39	3.30	4.38	1.00
1985/86 *	602	5/ 433	870	1,905	3.08	3.30	4.38	1.08
1986/87 *	830	5/ 463	528	1,821	2.42	2.40	4.38	1.98
1987/88 *	283	467	511	1,261	2.57	2.28	4.38	1.81
1988/89 *	190	287	225	702	3.72	2.21	4.23	0.69
1989/90 *	117	144	275	536	3.72	2.06	4.10	0.32
1990/91 *	163	14	691	868	2.61	1.95	4.00	1.28
1991/92 *	152	50	273	475	3.00	2.04	4.00	6/ 1.35
1992/93 *	150	28	353	531	3.24	2.21	4.00	0.81
1993/94 *	150	6	412	568	3.26	2.45	4.00	1.03
1994/95 *	142	0	365	507	3.45	2.58	4.00	0.61
1995/96 *	118	0	258	376	4.55	2.58	4.00	0
1996/97 *	95	0	349	444	4.35	2.58	NA	0.87
1997/98 * 7/	93	0	602	695	3.35	2.58	NA	0.63

--- = Not applicable.

NA= Not available.

* = Includes food security reserve.

1/ Farmer-owned reserve.

2/ May not add to total due to rounding.

3/ Growers who planted in excess of their normal crop acreage were eligible for a target price of \$3.08 per bushel.

4/ Deficiency payment rate, 1981/82 to 1995/96; production flexibility contract payment rate, thereafter.

5/ Includes special producer storage loan program.

6/ Winter wheat option 1.25.

7/ Projected as of August 12, 1997.

Source: *Wheat: Situation and Outlook Yearbook*. U.S. Department of Agriculture, Economic Research Service.
WHS-1997. March 1997.

Appendix table 3: U.S. wheat exports by selected programs

Fiscal Year	Section P.L.480	416	Food for Progress	Aid 1/	Total concessional	CCC export credit	Export enhancement program	Total U.S. wheat exports	Total concessional, CCC export credit, and EEP exports divided by total exports 2/
----- 1,000 Metric tons -----									Percent
1978/79	3,234	0	--	7	3,241	2,684	0	31,340	19
1979/80	2,785	0	--	44	2,829	1,945	0	36,066	13
1980/81	2,537	0	--	4	2,541	3,261	0	42,246	14
1981/82	2,978	0	--	0	2,978	3,725	0	44,607	15
1982/83	3,340	0	--	123	3,463	8,597	0	36,701	33
1983/84	3,442	0	--	0	3,442	11,406	0	41,699	36
1984/85	4,392	0	--	74	4,466	8,221	0	28,524	44
1985/86	4,685	76	--	513	5,274	7,740	4,916	24,626	59
1986/87	3,927	406	--	1	4,334	8,125	12,214	28,204	67
1987/88	3,321	1,186	--	292	4,799	9,273	26,679	40,523	80
1988/89	3,020	137	--	806	3,963	8,897	17,906	37,660	68
1989/90	2,985	0	52	28	3,065	7,759	12,806	28,064	70
1990/91	3,067	0	92	0	3,159	8,339	15,150	26,792	78
1991/92	2,286	0	130	0	2,416	12,334	21,111	34,322	76
1992/93 3/	2,043	890	1,067	NA	4,001	8,538	21,806	36,081	79
1993/94 3/	2,801	0	726	NA	3,527	5,874	18,157	31,145	75
1994/95 3/	1,491	0	457	NA	1,948	4,202	18,073	32,088	68

NA = Not available.

1/ U.S. Agency for International development Commodity Import Program.

2/ Shares of wheat exports take into consideration the overlap between sales under the EEP and export credit guarantee programs.

3/ Preliminary.

Sources: P.L.480 shipment data are compiled by U.S. Department of Agriculture, Economic Research Service as of 2/19/97; export credit guarantee and EEP data are from U.S. Department of Agriculture, Foreign Agricultural Service, Export Credits Divisions; export data are from U. S. Department of Agriculture, Economic Research Service, *Foreign Agricultural Trade of the United States*.

Figure 1: U.S. wheat exports by selected Programs and Total U.S. Wheat Exports, Fiscal Years 1978/79--1994/95

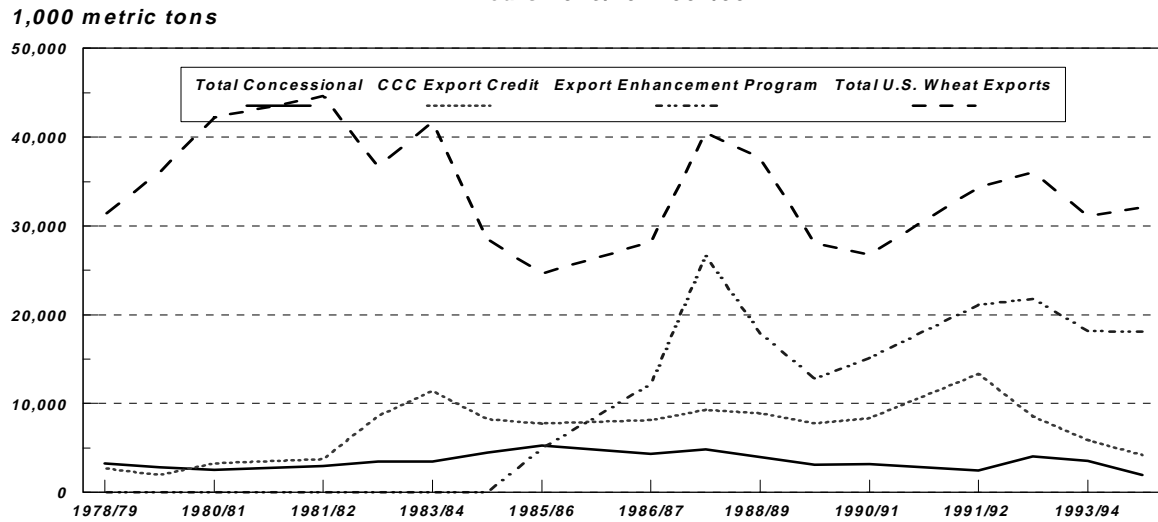


Figure 2: U.S. wheat farm price and loan rate, crop years 1974-96

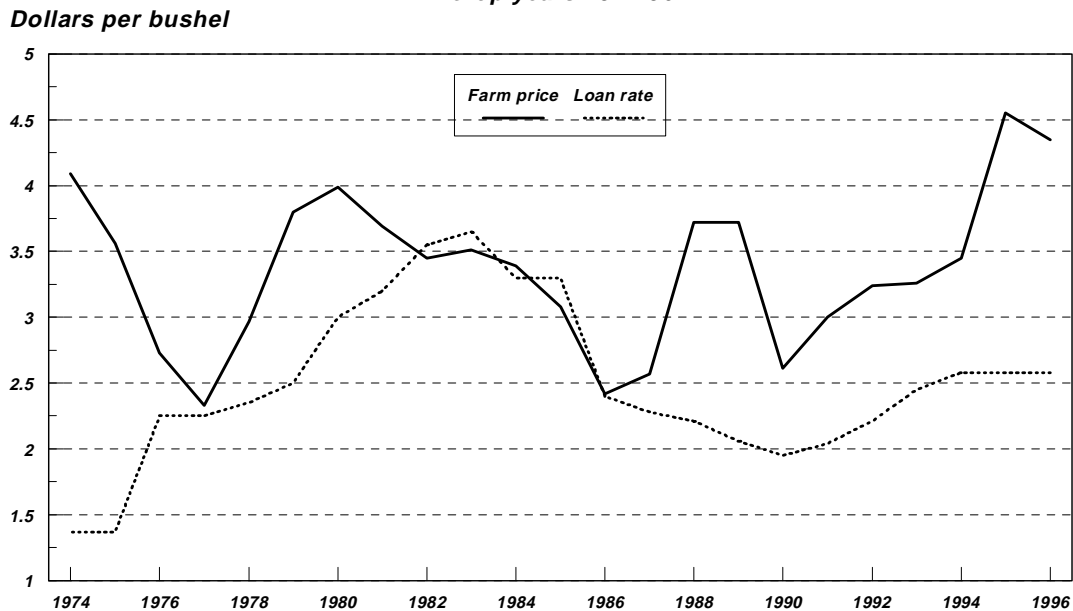


Figure 3: Ending stocks of U.S. wheat
Crop years 1974-96

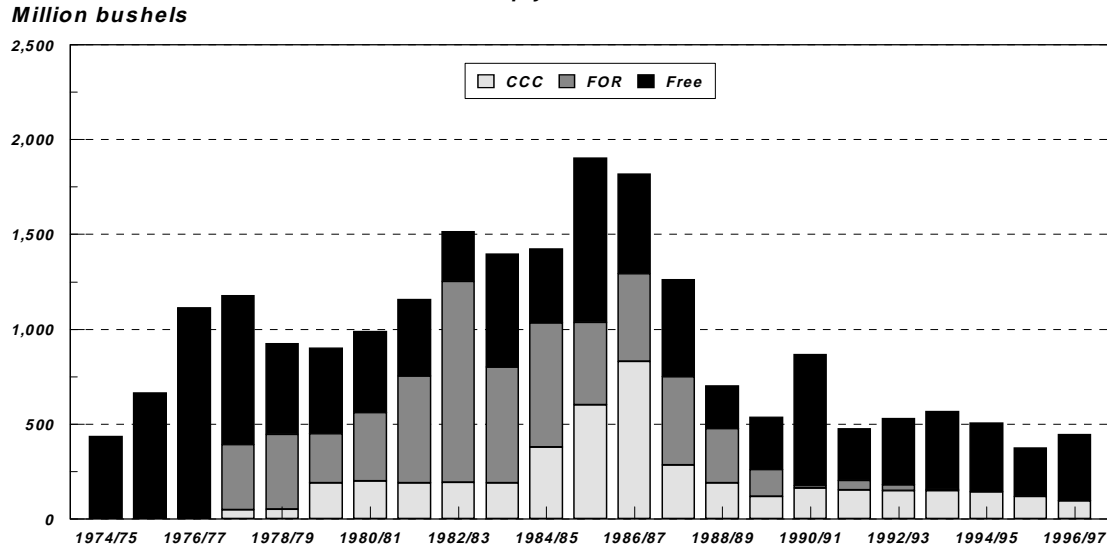
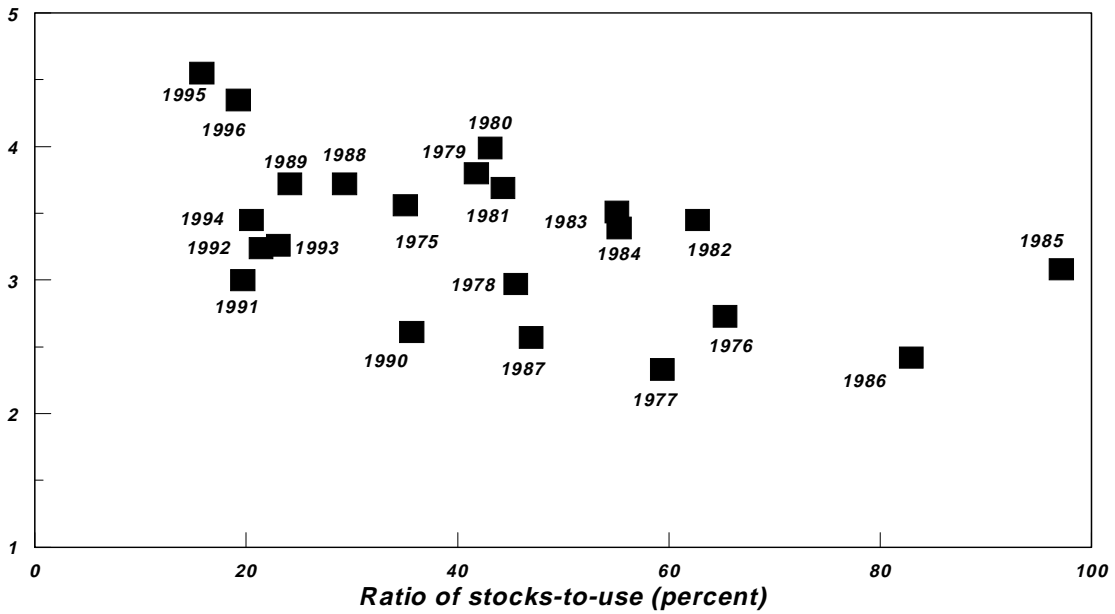


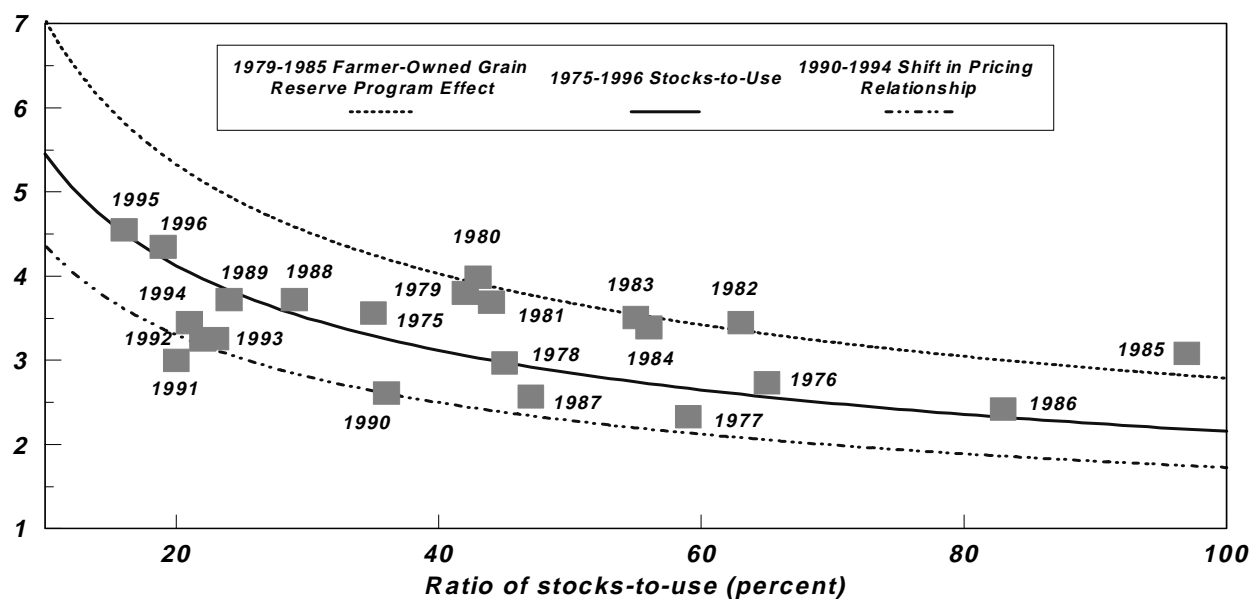
Figure 4: Annual farm price and stocks-to-use relationships, crop years 1975-96.

Season average farm price (dollars per bushel)



**Figure 5: Forecasts of all wheat producer price,
crop years 1975-96**

Season average farm price (dollar per bushel)



**Figure 6: Comparison of actual and estimated
annual producer prices for wheat, crop years
1975-96**

Season average farm price (dollar per bushel)

